Presenting a methodology for continuous and automated monitoring of mental state in horses using wearable technology

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Monitoring the mental state of horses is essential to the evaluation of their welfare and performance. The most common approach to evaluate mental state in horses is assessment of behaviour, with or without an equine ethogram. The drawbacks of this method are the subjectivity and the time needed. In this study a methodology is presented to monitor the mental state of horses in an automated way using wearable technology. For this purpose, 9 horses (3 mares, 6 geldings, 4-15 years) were monitored in 4 experiments (68 measurements), approved by the Animal Ethics Committee of KU Leuven. The presented methodology is based on the principle that a horse's heart rate can be divided in 3 parts: basic metabolism, activity and mental state or stress. In this study, activity of the horses was quantified by measuring physical activity directly on the horse. Metabolism was assumed constant during the short experiments and was not taken into further account. Using the measured activity of the horse, a simulated heart rate was calculated that only reflected changes in heart rate resulting from changes in activity. This was done by applying an autoregressive model with exogenous outputs with 2 a- and 2 b- parameters and a time delay of 1 second to the measured activity. Since the measured heart rate relates both to mental state and activity, it was hypothesised that the positive difference between the measured and simulated heart rate is a measure for the horse's mental state or stress. By computing the 20 second moving average of the horse's mental state followed by normalisation, the relative stress in percentage was obtained. The gold standard for stress in horses, behaviour, was obtained using an equine ethogram. Using the video recordings of the horses and a labelling tool developed by M3-BIORES, the occurrence of 13 types of negative behaviour was stored for each second of the experiment. This resulted in continuous equine behaviour data with the same sampling rate as the measured heart rate and activity, which enables validation of the mental state detection method. The same window averaging and normalisation procedure as for the simulated heart rate was applied to the labelled behaviour to obtain relative negative behaviour in percentage. For validation, the relative stress was compared with the relative negative behaviour. A peak detection algorithm was applied to both time series (min. peak distance=50 seconds, min. peak height=10%). Positive peaks were matched between stress and behaviour in a range of ± 50 seconds. Applying this validation procedure to all measurements resulted in a sensitivity of 77% and a precision of 78%. In conclusion, the presented method provides a reliable, automated and objective way to evaluate mental state

Lay person message: The mental state of horses provides essential information on their welfare and performance. The most common approach to evaluating mental state in horses is visual assessment of their behaviour, which is subjective and time consuming. This work presents a methodology to monitor the mental state of horses in an objective, continuous and automated way using wearable technology.

Keywords: Equine, behaviour, wearable technology, automated, monitoring, welfare.